

Annual cycle of populations of *Sphaeridia pumilis* (Collembola)

BY

J. P. BLANCQUAERT, J. MERTENS, R. COESSENS

Laboratorium voor Oecologie der Dieren, Zoögeografie en Natuurbehoud
K.L. Ledeganckstraat 35 - B-9000-Gent, België

INTRODUCTION

Previously we discussed the life history of some Symphypleona under experimental conditions. Some observations made on field populations of one of these species, *Sphaeridia pumilis* (Krausbauer, 1898) will be presented in this paper.

I. — METHODS

Two *Sphaeridia pumilis* populations, living in very different habitats, were studied at different periods by means of pitfall traps.

A. — A population was sampled in the State Nature Reserve « De Westhoek » (De PANNE, Belgium) from 30.4.73 to 10.4.74. This reserve is in a coastal area with negligible human influence. The sampling site is situated in a dune slack in a complex of parabolic dunes and is surrounded by a high *Hippophae-Ligustrum* layer. The covering is 90 %, consisting of bushes (60 % at a height of 1.00 to 1.80 m) an herbaceous layer (60 %, at a height of 0,15 to 1.00 m) and a moss layer (50 %).

The geomorphological and phytosociological characteristics of the area have been described by DEPUYDT (1967) and by HERBAUTS (1971). The meteorological data (daily precipitation, daily maximum and minimum temperatures, the mean temperatures for each two week capture period) were obtained from the KMI (Royal Meteorological Institute) at Ostend and are given in Fig. 1. Three pitfall traps, diameter 8 cm, partly filled with a saturated aqueous solution of picric acid, were placed at a distance of ± 3 m from each other throughout the sampling site. The contents of the traps were collected every

Reçu le 30-9-82.

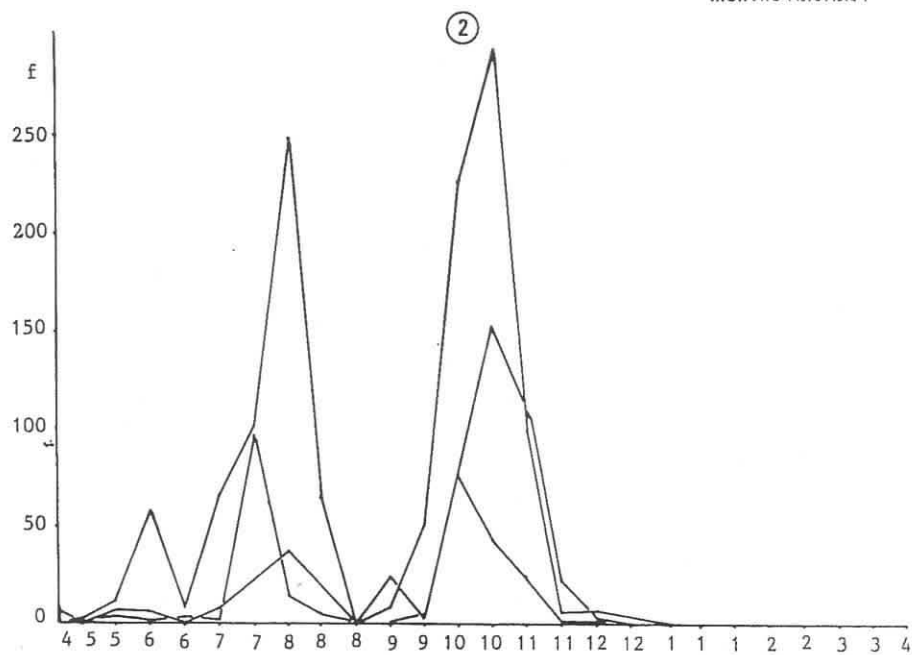
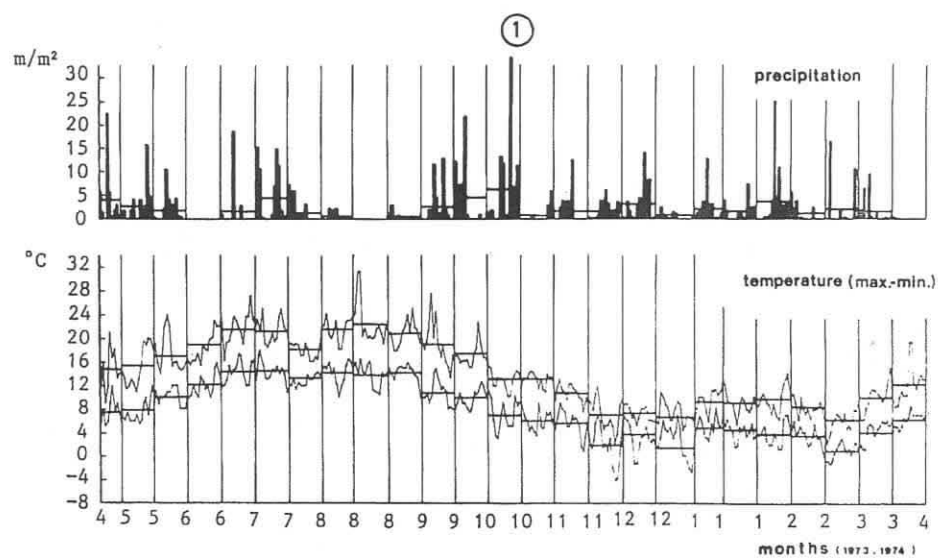


FIG. 1. — Precipitation and temperature (max., min.) for the period from 30.4.73 to 10.4.74 at Ostend. The mean values for the capture periods are given by a horizontal line in the columns.

FIG. 2. — Number of the springtails trapped for the successive capture periods from the « Westhoek ».

fortnight. For a detailed description of the sampling method we refer to MAELFAIT and BAERT (1975).

B. — From 17.9.76 to 21.9.77 a series of 10 small pitfall traps (diameter 1,4 cm) were placed at 20 cm intervals on the grass verge of a railroad at Belsele (Belgium). This sampling site was completely covered by grasses (*Agrostis vinealis* Schreb., *Holcus mollis* L., *Anthoxanthum odoratum* L.). A 70 % alcohol solution was used as fixing and preserving agent. The contents of the traps were collected every 48 hours in spring and autumn, and every 96 hours in summer and winter.

For each capture period we calculated mean temperature, total precipitation and saturation deficit from the monthly bulletins of the KMI. These data are given in Fig. 3.

The maintenance of stockcultures and the experimental conditions have been described earlier (BLANQUAERT, MERTENS 1979).

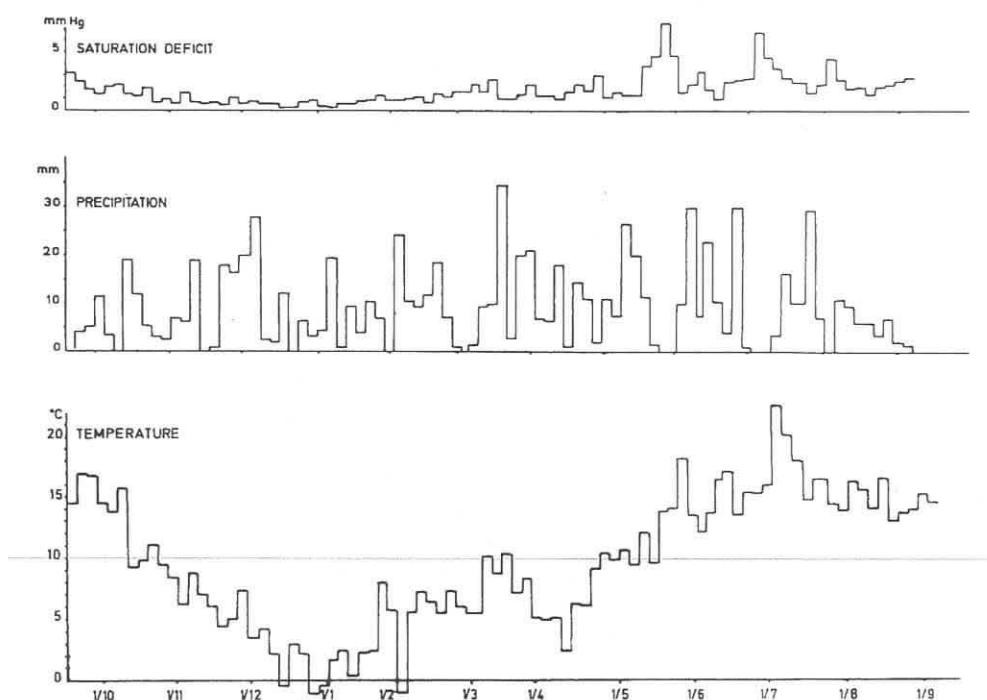


FIG. 3. — Saturation deficit (1), precipitation (2) and mean temperature (3) for the period from 17.9.76 to 21.9.77.

II. — RESULTS

The yields of the pitfall traps in each capture period are given, for both populations sampled, in Fig. 2 and 4. It is striking that, in spite of the differences between the two habitats and the different trapping periods, the results are very congruent:

- A) No animals can be captured during the winter period (from mid-December to March);
- B) The trapping yields are fluctuating much during spring and summer; and
- C) In autumn the number of animals trapped is extremely high.

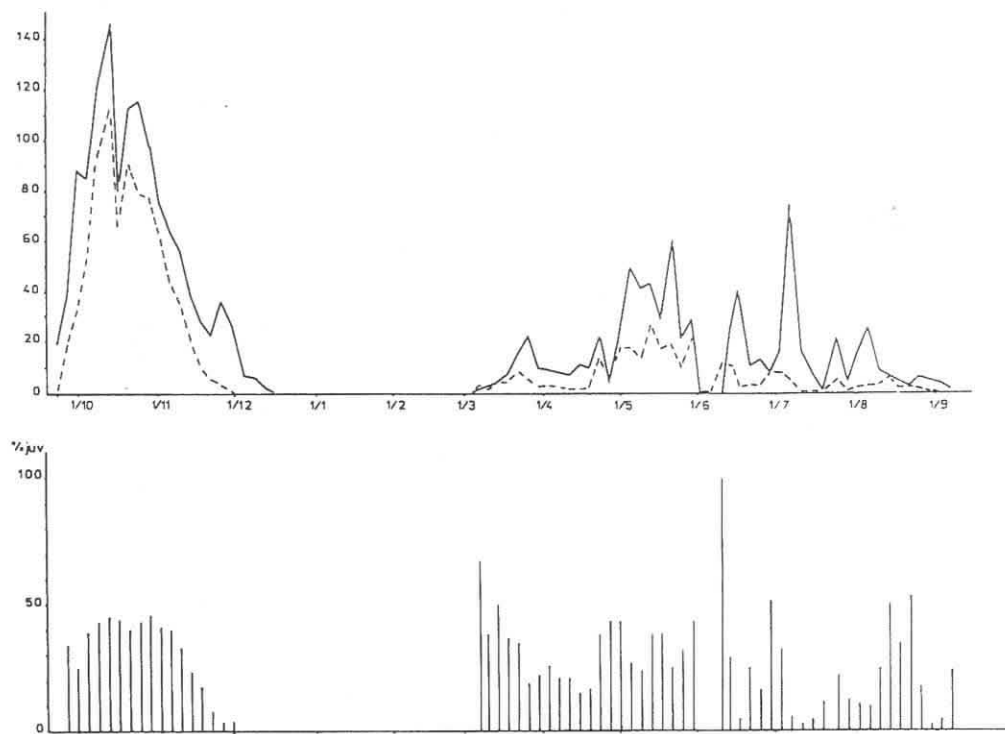


FIG. 4. — Number of springtails trapped (—adults, ...juveniles) in each capture period at Belsele.
Below: proportion of juveniles.

III. — DISCUSSION

A) The absence of *Sphaeridia pumilis* in the pitfall traps during the winter months could be due to:

1. a low locomotory activity connected with the low temperatures;
2. the absence of juvenile and adult animals in the population.

We observed that in soil samples, collected from the end of December to the end of February, only juvenile animals (in their first instar) can be extracted by the Tullgren technique at room temperature. So we think it logical to assume that in this period only eggs, and no adults are present in the population.

As described earlier (BLANQUAERT, *et al.*, 1981 a), we observed that in this species eggs produced during the winter months, even in laboratory conditions, are exclusively of the non-diapause type. At a suitable condition embryogenesis starts immediately after oviposition. However there is no embryonal development below 5° C.

B) Juvenile animals can be captured from the beginning of March onwards. The higher temperatures apparently permit development and hatching of the non-diapause eggs which constitute the winter population.

However the capture yields are very variable during spring and summer, being almost zero in a few capture periods in both populations sampled. The fluctuations are hard to explain, but from the meteorological data it seems that humidity is an important regulating factor during this period. Frequently a period with high temperature and no precipitation (high saturation deficit) is followed by a low yield capture. We think that a lowering of the locomotory activity of the animals in these conditions alone cannot explain these results. We observed that longevity is much shorter at higher temperatures (BLANQUAERT, *et al.*, 1981 b).

Furthermore WALTERS (1968) showed that in *Sminthurus viridis* hatching is inhibited by drought; eggs do not hatch at a saturation deficit of more than 5 mm Hg. It is striking that once rainfall has occurred after a period of drought, a relatively high number of juvenile animals is captured. This seems to confirm the statement of POINSOT-BALAGUER (1976) that in the dry season of the Mediterranean area hatching of the eggs, being the diapause type at this time, is enhanced by rainfall. Nevertheless we were unable to obtain a similar result in experimental conditions. These diapause eggs, laid during spring and summer, hatch in September, and it was not possible to induce hatching at an earlier time by subsequently drying and moistening them.

C) From mid-September onwards a large number of animals was trapped, among them a large proportion of juveniles. The high trapping yields might be partly due to an enhanced locomotory activity; we think that they reflect mainly a dramatic increase in population density, resulting from the hatching of the many diapause eggs produced during summer.

This high population density ends towards December, when mean temperatures reach the freezing point.

The annual cycle of a population of *Sphaeridia pumilis*

During the winter months only eggs of the non-diapause type are present. Development and activity in early spring are mainly temperature-dependent. So as a result of the increasing temperatures eggs hatch and give rise to a growing population, which in the beginning of March and adults.

The females have a life span of a few weeks, and their generation time is relatively long. Thus it can be expected that generations overlap considerably and that several generations are present at the same time in April.

Eggs produced from this time on are mainly of the diapause type. They represent the main aestivating stage and normally hatch in autumn. In

summer a period of high temperatures and low humidity seems to cause the death of most of the juvenile and adult population. However after some precipitation the population recovers quite quickly. It is not clear from which eggs the recovery of the population is generated.

In autumn non-diapause eggs are laid, which normally hatch within a few days. Hatching can however be delayed by low temperatures. As in winter most juvenile and adult animals probably die, these eggs represent the hibernating stage of the population.

Diapause and non-diapause eggs.

POINSOT-BALAGUER (1976) states that in the Mediterranean area *Sphaeridia pumilis* passes the summer by « œufs de résistance ou en diapause », confirming our observations that aestivating eggs occur in this species. She concludes that the hatching of these eggs is regulated by a combination of temperature and humidity changes. At first sight our observation that a population can be quickly restored after a dry and warm period could lead us to a similar conclusion. But we are puzzled by the fact that in our continuous laboratory conditions (BLANCQUAERT *et al.*, 1981) eggs produced from spring onwards, even by females cultured *in vitro* for several generations, do not develop immediately, are real « diapause eggs » and represent the aestivating stage of the species.

So two important problems are left:

- From which type of eggs an extinct population can restore itself after a period of drought in summer? From non-diapause eggs? Our observations do not allow us to accept that this type is present in summer. Or from diapause eggs? If the statement of Poinso-Balaguer is correct that changes in humidity and temperature can cause the hatching of these eggs, how is this to be combined with our *in vitro* observations?
- How is hatching of the diapause eggs regulated in autumn? In our constant experimental *in vitro* conditions (complete darkness, constant high relative humidity, constant temperature and constant food supply), diapause eggs, even those produced by females cultivated for several generations in the same constant experimental conditions, hatch in September. The mechanism is not clear to us at the moment. We think some exogenous factor, which is not temperature or temperature change, humidity, photoperiod, food or population density, is involved.

SUMMARY

Two populations of *Sphaeridia pumilis* are studied by means of pitfall traps. An attempt to reconstruct the annual cycle of a population of this springtail is made. The problem of the possible factors regulating the hatching of diapause and non-diapause eggs is discussed.

RÉSUMÉ

Cycle annuel des populations de *Sphaeridia pumilis* (Collembola)

Deux populations de *Sphaeridia pumilis* ont été étudiées à l'aide de pièges Barber. Un essai est tenté pour établir le cycle annuel d'une population de ce collembole. Le problème des facteurs régulateurs qui puissent induire l'éclosion des œufs « normaux » et de « diapause » est discuté.

REFERENCES

- BLANQUAERT (J. P.) & MERTENS (J.), 1979. — Postembryonal development in *Megalothorax minimus* (Willem, 1900) (Collembola). *Rev. Ecol. Biol. Sol*, **16**: 125-130.
- BLANQUAERT (J. P.), COESSENS (R.) & MERTENS (J.), 1981. — Life history of some Symphypleona under experimental conditions. I. Embryonal development and diapause. *Rev. Ecol. Biol. Sol*, **18**: 115-126.
- BLANQUAERT (J. P.), COESSENS (R.) & MERTENS (J.), 1981. — Life history of some Symphypleona under experimental conditions. II Postembryonal development and reproduction. *Rev. Ecol. Biol. Sol*, **18**: 373-390.
- DEPUYDT (F.), 1967. — Bijdrage tot de geomorfologische en fytogeografische studie van het domaniaal natuurreservaat « De Westhoek ». Publ. Min. van landbouw, 3.
- HERBAUTS (J.), 1971. — Flore et végétation des dunes de la réserve naturelle domaniale de Westhoek. Publ. Min. van Landbouw, 5.
- MAELFAIT (J. P.) & BAERT (L.), 1975. — Contribution to the knowledge of the arachno- and entomofauna of different wood habitats. *Biol. Jb Dodonaea*, **43**: 179-196.
- POINSOT-BALAGUER (N.), 1976. — Dynamique des communautés de collemboles en milieu xérique méditerranéen. *Pedobiologia*, **16**: 1-17.
- WALTERS (M. C.), 1968. — A study of *Sminthurus viridis* (L.) (Collembola) in the Western Cape Province. *Ent. Mem.*, **16**: 1-98.